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## ARTICLE IV.

*Silver Ores reduced by the Method of Becquerel. By Andres del Rio.  
Read November 5, 1830.*

I HAVE the honour to present to the American Philosophical Society, the result of some curious researches, which in more dexterous hands may become interesting. They were suggested to me by the beautiful experiment of M. Becquerel, inserted in the *Annales de Chimie et de Physique*, for September 1829. He introduced, into a glass tube, some carburet of sulphur, with a solution of nitrate of copper, which, being of less specific gravity, floated upon its surface; and by means of a copper wire he established a communication between the two liquids. He observed that the surface of the wire became coated with protoxide of copper, while small tables, assuming a metallic and glistening appearance, were deposited on the sides of the glass tube. These M. Wohler has since shown to be formed of sulphuret of copper; whence he considers the method of Becquerel as being merely "a new mode of forming sulphurets," to which, I think, he should have added, "by the decomposition of other sulphurets." Indeed, I introduced severally into three small glass tubes, some small lamellæ of ductile and some fragments of brittle silver glance and red silver ore. These, being exposed to the action of nitrate of copper and a copper wire, were reduced in eight days to the state of metallic silver. I repeated the experiment on the ores in small fragments, which became coated with silver in five days. The formation of silver was even apparent on the second day at the points in which the ore came in contact

with the glass. By what process nature invests silver glance and red silver ores with native silver in the mines, is a question which I do not pretend to solve.

In operating upon the fragments of silver glance, which were coated in the preceding experiments with metallic silver, I added a little quicksilver. In fifteen days the ore was transformed into an amalgam of silver. The brittle sulphuret and the red silver ore required nearly three weeks for their complete amalgamation. According to M. Wohler the carburet of sulphur is decomposable in the same way by diluted nitric acid. I did not succeed in decomposing the dark red silver ore by nitric acid, until after a subsequent saturation of the acid with copper.

These experiments afford us instances of the reduction of silver ores without common salt, and sulphuret of iron and copper (the *magistral* of the Mexicans). I always suspected that the latter substance was very mischievous in the process of amalgamation, occasioning the great loss of silver and mercury which are daily experienced. The silver, being oxidized at the expense of the sulphuric acid, retains its oxygen with more tenacity, as has been shown by M. Berthier, than had been previously admitted; and especially when in contact with the oxide of copper, which possesses this property to a high degree. The same probably happens with the mercury; and the sulphates, bisulphates, and subsulphates which are thus formed are lost for ever in the process of washing. Hence, I think, they roast their silver ores in Saxony with common salt alone; and they treat the chloride of silver by mercury. By this means the loss of mercury amounts only to four ounces per five marcs of silver obtained in the working of ores that contain two ounces per quintal\*. How satisfied would we be in Mexico if our loss were no greater.

I trust that the pupils of the college of mines of Mexico may derive some advantage from these small experiments of mine. Perhaps I have thus approximated to the discovery made by my lamented pupil *Valencia*, and which he unfortunately carried with him to the grave.

\* The Mexican amalgamator divides his loss of mercury into two parts; the first he terms *consumido*, which is always equal at least to the weight of silver obtained. The second, termed *perdida*, is the waste in washing, &c.

I can state as a fact, that by his genius he had discovered the means of avoiding the loss of mercury termed the *consumido*. Such are the fruits resulting from colleges of mines. In my last letter I suggested to him the use of the protomuriate of tin, not of the nitrate of copper; and in his reply he informed me that his method was so simple, that he feared the workmen would deprive him of the fruits of it. As the mail was closing, he postponed the communication to his next letter, which however he never had an opportunity of writing, having previously, as well as many others of my able pupils, fallen a victim in the war of independence.

Should the Philosophical Society continue their liberality to me, by supplying me with a fragment of the white silver glance (*weisgulden* of the Germans), I propose to extend my experiments to that ore.